

SHORT COMMUNICATION

First record of paternal care in the family Stygnidae (Opiliones: Laniatores)

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Abstract. Two cases of paternal care are described for species of the genus *Stenostygnellus* (Stygnidae), *S. flavolimbatus* Roewer 1913 and *S. aff. flavolimbatus*, both from Venezuela. Males of both species guard multiple clutches containing a large number of eggs, which are laid under rotting logs (*S. flavolimbatus*) or in the base of palm petioles (*S. aff. flavolimbatus*). These records probably represent a new and independently evolved case of paternal care in harvestmen.

Keywords: Egg-hiding, *Eutimesius*, maternal care, *Protimesius*, *Stenostygnellus*

Exclusive post-zygotic paternal care is regarded as the rarest form of parental investment among arthropods, being reported for only 17 lineages (Tallamy 2000, 2001; Nazareth & Machado 2010). Over half of the reports of independent evolution of paternal care in arthropods occurred in the order Opiliones, a group of arachnids with nearly 6500 described species (Kury 2003). Contrary to maternal care, which is restricted in harvestmen to species of the Neotropical superfamily Gonyleptoidea (Machado 2007; Machado & Macías-Ordóñez 2007), paternal care has evolved in at least four superfamilies of the suborder Laniatores: once in the Triaenonychoidea (family Triaenonychidae), once in the Samoidea (family Podoctidae), once in Assamioida (family Assamiidae), and at least three times in the Gonyleptoidea (family Gonyleptidae) (references in Machado et al. 2004; Machado 2007; Nazareth & Machado 2009). In this paper, we report for the first time paternal care in representatives of Stygnidae and also offer anecdotal behavioral information on other species in order to discuss the evolution of the different forms of parental care in this family.

We made opportunistic observations of paternal behavior during two field expeditions devoted to the collection of arachnological material in Venezuela. The two species we studied belong to the genus *Stenostygnellus* Roewer (Heterostygninae), a small group of Neotropical harvestmen restricted to forested areas in the northern mountains of Venezuela. Although only two species are currently recognized in the genus, *S. flavolimbatus* Roewer 1913 and *S. macrochelis* (Roewer 1917) (see Pinto-da-Rocha 1997), the systematics of the group deserve further study (Villarreal 2007). We found the first species, *S. flavolimbatus*, at the El Ávila National Park (10°31'5.95"N, 66°48'21.87"W; ca 1700 m elev.), Distrito Capital, Venezuela. We observed this species along the trail between the Humboldt Hotel and the La Silla del Ávila in July 2006. The second species, identified as *S. aff. flavolimbatus*, is probably a new species (O. Villarreal-Manzanilla unpublished data). We observed this species in a cloud forest near Colonia Tovar (10°24'56.30"N, 67°17'12.64"W; ca 2000 m elev.), state of Aragua, in July 2008. Voucher specimens of males are deposited in the arachnological collection of the Museo del Instituto de Zoología Agrícola (MIZA), Maracay, Venezuela.

We found two males of *S. flavolimbatus* guarding clutches of eggs nearly 50 cm from each other in a cavity in a large rotting log. Both males were resting close to a clutch containing more than 100 eggs in different stages of embryonic development (based on differences of

color and size). We interpret the presence of the males close to the clutches as parental care because both males maintained the typical posture exhibited by parental individuals in other harvestman species (see Machado et al. 2004; Machado & Warfel 2006). The presence of eggs in different stages of embryonic development, which is common among harvestmen exhibiting exclusive paternal care (Machado et al. 2004; Machado & Macías-Ordóñez 2007), suggests that guarding males accept eggs from more than one female or from the same female at different times.

We also found one male and one female of *S. aff. flavolimbatus* close to a clutch laid in the base of a palm petiole. The clutch contained nearly 150 eggs in at least two different stages of embryonic development, and the eggs were in multiple layers (Fig. 1A) – a pattern of egg deposition only described for another species with paternal care, the assamiid *Lepchana spinipalpis* (Martens 1993). When we photographed the clutch, both individuals were disturbed, but only the female abandoned the oviposition site. The male remained close to the clutch and constantly tapped the eggs with his second pair of legs (Fig. 1A). We interpret the presence of the male close to the eggs as parental care because the individual did not abandon the clutch after disturbance. Moreover, the male inspected the clutch after disturbance with his sensorial legs, like parental individuals of other harvestman species usually do after disturbance (e.g. Mora 1990; Machado et al. 2004). The presence of a female close to the clutch, on the other hand, does not necessarily indicate biparental care because harvestman females usually remain for some time at the oviposition site, both before and after egg laying (Mora 1990; Nazareth & Machado 2009, 2010).

The only previously studied species of Stygnidae is the Amazonian *Auranus parvus* Mello-Leitão 1941 (Stygninae), which lays its eggs inside fissures on the bark and provides no further care (Friebe & Adis 1983). Laboratory observations on two other Amazonian Stygninae, *Stygnus* sp. and *Protimesius longipalpis* (Roewer 1943), indicate that females also hide their eggs inside fissures in rotting logs and do not provide additional care to the offspring (G. Machado unpublished data). Given the phylogenetic position of the genera *Auranus*, *Stygnus*, and *Protimesius* within the Stygninae (Pinto-da-Rocha 1997; Pinto-da-Rocha & Villarreal-Manzanilla 2009), the plesiomorphic form of parental care in the subfamily is probably egg-hiding.

Our observations on *Stenostygnellus* spp. are the only reproductive data for the subfamily Heterostygninae. In March 2004, however, we received a photo of a stygnid harvestman from Tiputini

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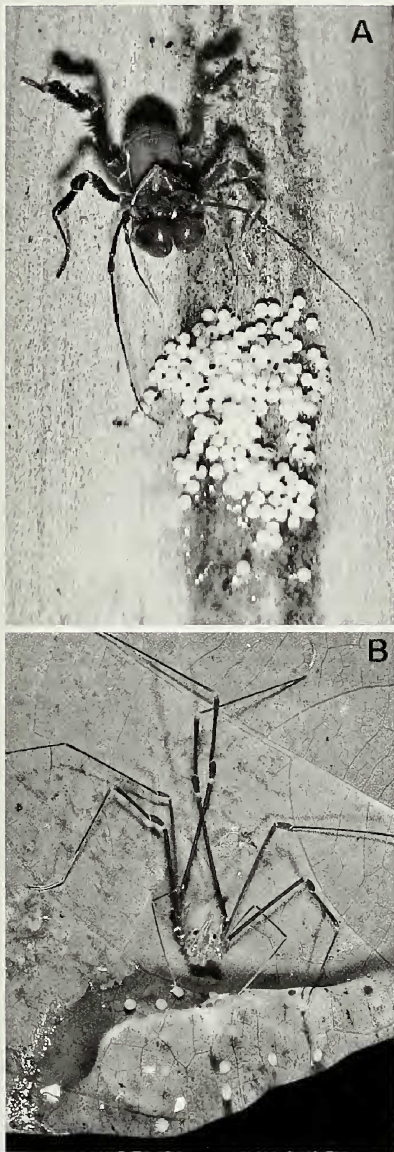


Figure 1.—A. Male of *Stenostygnellus* aff. *flavolimbatus* close to a multiple clutch laid on the petiole of a palm. The guarding male is touching the eggs with his second pair of legs (photo: O. Villarreal). B. Female of *Eutimesius* sp. prostrated close to eggs laid on a leaf and surrounded by an abundant mucus coat (photo: Bejat McCracken).

Biodiversity Station, Ecuador, probably caring for eggs imbedded in an abundant mucus coat (Fig. 1B). We unequivocally identified the individual, which almost certainly belongs to the genus *Eutimesius* Roewer 1913, as being a female, based on the relative small size of the chelicerae and the lack of apical spines on femur IV (see Pinto-da-Rocha 1997). Anecdotal field observations indicate that the female remained close to the clutch for some days and did not consume the eggs (B. McCracken pers. comm.), which we interpret as probable maternal care. The genus *Eutimesius* is the sister group of the clade formed by the genera *Stygnoplus* + *Stenostygnellus* (Pinto-da-Rocha 1997). Unfortunately, the lack of behavioral data on the basal lineages of Heterostygninae, as well as on the monotypic Nomoclastinae, makes it difficult to present a hypothesis for the evolution of the different forms of parental care in Stygnidae. Nevertheless, it is likely that the cases of post-zygotic parental care we describe represent independent events of evolution of both maternal and paternal assistance in harvestmen of the superfamily Gonyleptoidea.

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LITERATURE CITED

- Friebe, B. & J. Adis. 1983. Entwicklungzyklen von Opiliones (Arachnida) im Schwarzwasser-Überschwemmungswald (Igapó) des Rio Tarumã Mirim (Zentralamazonien, Brasilien). *Amazoniana* 8:101–110.
- Kury, A.B. 2003. Annotated catalogue of the Laniatores of the New World (Arachnida, Opiliones). *Revista Ibérica de Aracnología*, volume especial monográfico 1:1–337.
- Machado, G. 2007. Maternal or paternal egg guarding? Revisiting parental care in triaenonychid harvestmen (Opiliones). *Journal of Arachnology* 35:202–204.
- Machado, G. & R. Macías-Ordóñez. 2007. Reproduction. Pp. 414–454. *In* *Harvestmen: the Biology of Opiliones*. (R. Pinto da Rocha, G. Machado & G. Giribet, eds.). Harvard University Press, Cambridge, Massachusetts.
- Machado, G., G.S. Requena, B.A. Buzatto, F. Osses & L.M. Rossetto. 2004. Five new cases of paternal care in harvestmen (Arachnida: Opiliones): implications for the evolution of male guarding in the Neotropical family Gonyleptidae. *Sociobiology* 44:577–598.
- Machado, G. & J. Warfel. 2006. First case of maternal care in the family Cranaidae (Opiliones: Laniatores). *Journal of Arachnology* 34:269–272.
- Martens, J. 1993. Further cases of paternal care in Opiliones (Arachnida). *Tropical Zoology* 6:97–107.
- Mora, G. 1990. Parental care in a neotropical harvestman, *Zygopachylus albomarginis* (Arachnida: Gonyleptidae). *Animal Behaviour* 39:582–593.
- Nazareth, T.M. & G. Machado. 2009. Reproductive behavior of *Chavesincola inexpectabilis* (Opiliones: Gonyleptidae), with the description of a new and independently evolved case of paternal care in harvestman. *Journal of Arachnology* 37: 127–134.
- Nazareth, T.M. & G. Machado. 2010. Mating system and exclusive post-zygotic paternal care in a neotropical harvestman (Arachnida: Opiliones). *Animal Behaviour* 79:547–554.

- Pinto-da-Rocha, R. 1997. Systematic review of the neotropical family Stygnidae (Opiliones, Laniatores, Gonyleptoidea). *Arquivos de Zoologia* 33:163–342.
- Pinto-da-Rocha, R. & O. Villarreal-Manzanilla. 2009. Cladistic analysis of the Styginiinae and description of a new species of *Prothnesus* Roewer, 1913 (Opiliones: Stygnidae). *Zootaxa* 2176:48–56.
- Tallamy, D.W. 2000. Sexual selection and evolution of exclusive paternal care in arthropods. *Animal Behaviour* 60:559–567.
- Tallamy, D.W. 2001. Evolution of exclusive paternal care in arthropods. *Annual Review of Entomology* 46:139–165.
- Villarreal, M.O. 2007. Notes on the genus *Stenostygnellus* Roewer (Opiliones: Stygnidae) in Venezuela. Pp. 123. *In* Abstract, 17 International Congress of Arachnology. (A.D. Brescovit & G. Machado, eds.). FAPESP, São Pedro, São Paulo, Brazil.

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